“DIAGNOSTIC PERFORMANCE OF COMPUTED TOMOGRAPHIC CORONARY ANGIOGRAPHY FOR EVALUATION OF CORONARY ARTERY STENSOSIS IN INDIVIDUALS WITH TYPICAL OR ATYPICAL CHEST PAIN WITHOUT KNOWN CORONARY ARTERY DISEASE”

DISSERTATION SUBMITTED TO

THE TAMIL NADU Dr. M.G.R MEDICAL UNIVERSITY, CHENNAI

IN PARTIAL FULFILLMENT OF THE REGULATIONS FOR THE

AWARD OF DEGREE OF M.D IN RADIODIAGNOSIS.

BY

DR . SUGANYA SUBBULAKSHMI.J

GUIDE : DR .ELANGO MD DMRD

DEPARTMENT OF RADIOLOGY

PSG INSTITIUTE OF MEDICAL SCIENCES AND RESEASRCH

PEELAMEDU, COIMBATORE – 641004

TAMILNADU, INDIA

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CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **"DIAGNOSTIC PERFORMANCE OF COMPUTED TOMOGRAPHIC CORONARY ANGIOGRAPHY FOR EVALUATION OF CORONARY ARTERY STENSOSIS IN INDIVIDUALS WITH TYPICAL OR ATYPICAL CHEST PAIN WITHOUT KNOWN CORONARY ARTERY DISEASE"** is the bonafide original work of **Dr.Suganya Subbulakshmi.J** in the department of Radiodiagnosis, PSG Institute of Medical Sciences and Research, Coimbatore in partial fulfillment of the regulations for the award of degree of M.D in Radiodiagnosis.

Signature of the guide
Dr. Elango .R MD DMRD
Professor of Radiology
Department of
Radiology
P.S.G IMSR,
Coimbatore

CERTIFICATE

PSG INSTITIUTE OF MEDICAL SCIENCES AND RESEASRCH

COIMBATORE

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Dr. B.DevAnand
Professor and HOD
Department of Radiodiagnosis
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Dr.S. Ramalingam
Principal
PSG IMS & R

Place : Coimbatore

Date :

ACKNOWLEDGEMENT

Foremost, I would like to express my sincere gratitude to my professor and HOD **Dr. B. Devanand** and my guide **DR .Elango** for his ever friendly co-operation which was present throughout the preparation of this work. This work would not have been possible without his guidance, support and encouragement. **Dr. B. Devanand** will always be a key inspiration to me.

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PSG Institute of Medical Sciences & Research
Institutional Human Ethics Committee

Recognized by The Strategic Initiative for Developing Capacity in Ethical Review (SIDCER)
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June 23, 2014

To
Dr J Suganya Subbulakshmi
Postgraduate
Department of Radiology
PSG IMS & R
Coimbatore

The Institutional Human Ethics Committee, PSG IMS & R, Coimbatore -4, has reviewed your proposal on 16th May, 2014 in its expedited review meeting held at IHEC Secretariat, PSG IMS&R, between 10.00 am and 11.00 am, and discussed your study proposal entitled:

"Diagnostic performance of computed tomographic coronary angiography for evaluation of coronary artery stenosis in comparison with conventional angiogram in patients without known coronary artery disease"

The following documents were received for review:

1. Duly filled application form
2. Proposal
3. Informed consent forms
4. Proforma
5. Permission letter from the concerned Head of Department
6. CV
7. Budget

After due consideration, the Committee has decided to approve the study.

The members who attended the meeting at which your study proposal was discussed are as follows:

Name	Qualification	Responsibility in IHEC	Gender	Affiliation to the Institution Yes/No	Present at the meeting Yes/No
Dr P Sathyan	DO, DNB	Clinician, Chairperson	Male	No	Yes
Dr S Bhuvaneshwari	M.D	Clinical Pharmacologist Member - Secretary	Female	Yes	Yes
Dr Sudha Ramalingam	M.D	Epidemiologist Alt. Member - Secretary	Female	Yes	Yes
Dr Y S Sivan	Ph D	Member –Social Scientist	Male	Yes	Yes
Dr D Vijaya	Ph D	Member – Social Scientist	Female	Yes	Yes

The approval is valid for one year.

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Phone : 91 422 - 2598822, 2570170, Fax : 91 422 - 2594400, Email : ihec@psgimsr.ac.in

We request you to intimate the date of initiation of the study to IHEC, PSG IMS&R and also, after completion of the project, please submit completion report to IHEC.

This Ethics Committee is organized and operates according to Good Clinical Practice and Schedule Y requirements.

Non-adherence to the Standard Operating Procedures (SOP) of the Institutional Human Ethics Committee (IHEC) and national and international ethical guidelines shall result in withdrawal of approval (suspension or termination of the study). SOP will be revised from time to time and revisions are applicable prospectively to ongoing studies approved prior to such revisions.

Kindly note this approval is subject to ratification in the forthcoming full board review meeting of the IHEC.

Yours truly,

SECRETARY
PSG IMS&R
COIMBATORE-641004.
INSTITUTIONAL HUMAN ETHICS COMMITTEE

23.6.17

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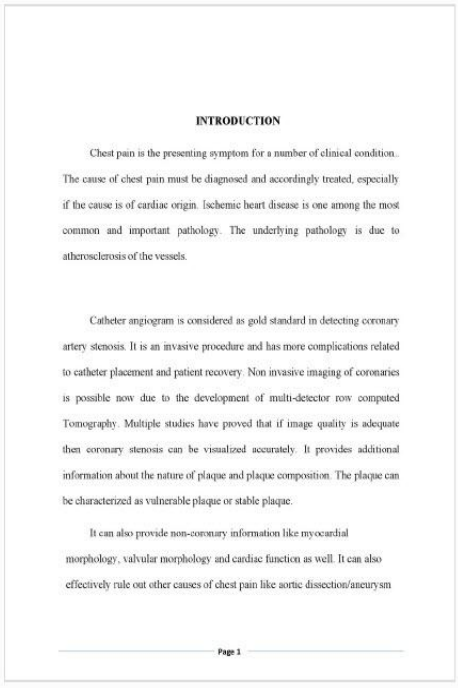

INTRODUCTION

Chest pain is the presenting symptom for a number of clinical condition.. The cause of chest pain must be diagnosed and accordingly treated, especially if the cause is of cardiac origin. Ischemic heart disease is one among the most common and important pathology. The underlying pathology is due to atherosclerosis of the vessels.

Catheter angiogram is considered as gold standard in detecting coronary artery stenosis. It is an invasive procedure and has more complications related to catheter placement and patient recovery. Non invasive imaging of coronaries is possible now due to the development of multi-detector row computed Tomography. Multiple studies have proved that if image quality is adequate then coronary stenosis can be visualized accurately. It provides additional information about the nature of plaque and plaque composition. The plaque can be characterized as vulnerable plaque or stable plaque.

It can also provide non-coronary information like myocardial morphology, valvular morphology and cardiac function as well. It can also effectively rule out other causes of chest pain like aortic dissection/aneurysm

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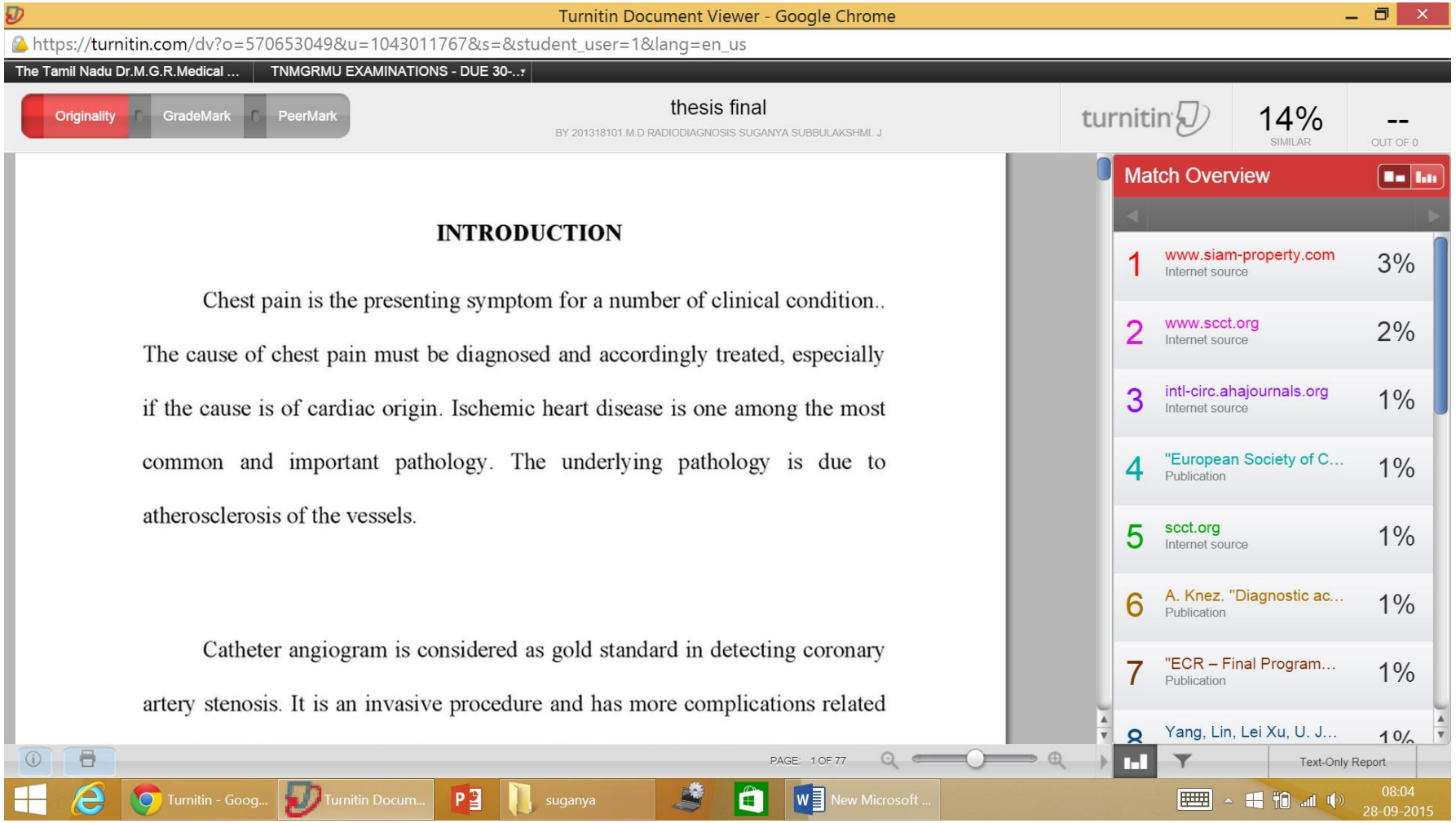
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INTRODUCTION
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ABSTRACT

AIM & OBJECTIVE

Primary Aim of the study

1. Detection of coronary artery stenosis with CT coronary angiography in comparison with conventional coronary angiography
2. Correlation of grading of stenosis in CT coronary angiography with conventional coronary angiography

Secondary aim

To assess the normal luminal diameter of coronary arteries on CT coronary angiography in Indian population

MATERIAL AND METHODS

In our prospective cohort study, which includes 20 patients presenting with typical/ atypical chest pain who underwent both CT and catheter coronary angiogram were included in the study. Vessels were analyzed on segment basis for any stenosis if so they were graded accordingly

RESULTS

Stenosis of more than 50% was considered as significant stenosis. Sensitivity, specificity, PPV and NPV for significant stenosis were 93%, 98%. 90% and 98% respectively in our study. Over all sensitivity, specificity, PPV and NPV for detecting stenosis in CT was. 87.8%, 97.9%, 92.3 %and 96.5% respectively.

CONCLUSION

Based on the study CT coronary angiography is sensitive in detecting clinically significant stenosis provided the quality of the image is adequate.

INTRODUCTION

Chest pain is the presenting symptom for a number of clinical condition.. The cause of chest pain must be diagnosed and accordingly treated, especially if the cause is of cardiac origin. Ischemic heart disease is one among the most common and important pathology. The underlying pathology is due to atherosclerosis of the vessels.

Catheter angiogram is considered as gold standard in detecting coronary artery stenosis. It is an invasive procedure and has more complications related to catheter placement and patient recovery. Non invasive imaging of coronaries is possible now due to the development of multi-detector row computed Tomography. Multiple studies have proved that if image quality is adequate then coronary stenosis can be visualized accurately. It provides additional information about the nature of plaque and plaque composition. The plaque can be characterized as vulnerable plaque or stable plaque.

It can also provide non-coronary information like myocardial morphology, valvular morphology and cardiac function as well. It can also effectively rule out other causes of chest pain like aortic dissection/aneurysm and pulmonary thrombo embolism in the same study. CT is also fast and simple.

We in our prospective study wish to determine the diagnostic efficacy of Multi Detector Computed Tomography coronary angiography considering Catheter angiogram as gold standard and whether CT can replace Catheter angiogram for diagnosis, while the latter can solely be reserved for therapeutic applications.

AIMS & OBJECTIVES

AIM OF THE STUDY:

Primary Aim of the study

1. Detection of coronary artery stenosis with CT coronary angiography in comparison with conventional coronary angiography
2. Correlation of grading of stenosis in CT coronary angiography with conventional coronary angiography

Secondary aim

To assess the normal luminal diameter of coronary arteries on CT coronary angiography in Indian population

MATERIALS AND METHODS

INCLUSION CRITERIA:

- Patients presenting with typical / atypical chest pain undergoing both CT coronary angiogram and catheter angiogram
- Patients who are capable of understanding the study constraints and conform with the guidelines of informed consent

EXCLUSION CRITERIA:

- Pregnancy.
- Patient allergic to iodinated contrast
- Serum Creatinine greater that 1.4 mg/dl
- Cardiac rhythm abnormalities.
- Patients with heart rate >70bpm and in whom beta-blocker, calcium-channel blocker are contraindicated.
- K/C/O Coronary artery disease
- Patient who did not undergo a subsequent catheter angiogram
- Calcium score of more than 600

MATERIAL & METHODS:

A total of 20 consecutive patients (from the year 2013-2014) with chest pain, referred for CTCA and subsequently assessed by catheter angiogram were included.

The study was conducted in the department of radiology at PSG Hospital

Scanning equipment

CECT was performed in multi detector Siemens SOMATOM Definition edge 128 slice scanner.

Pre procedure requirements

1. NPO for 6 hours.
2. 18 gauge intravenous catheter in right anticubital vein
3. Beta blocker (T.Metoprolol 25-100mg) to achieve heart rate of less than 70 beats per minute
4. Sublingual Nitroglycerin spray

Patient positioning

Patient in supine position with arms raised above head and heart centered within the gantry.

Contrast

Intravenous contrast—Non ionic iodinated contrast 370mg iodine /ml injected through pressure injector at a rate of 5.5 ml/sec, with a dosage of 1.0-1.5 ml / kg followed by saline chase of 40ml (5.5ml/sec)

Scanning technique

Retrospective ECG gating is used for image reconstruction

Following series were obtained-

- Scanogram
- Plain CT
- Post contrast study

Scanogram

Scanogram is taken in suspended inspiration.

Plain CT

From the scanogram field of view is chosen.

Plain scan is done in suspended inspiration.

Post contrast

From plain images FOV is chosen accordingly from just distal to coronary ostium till the cardiac apex to give adequate margin for movement during respiration. Image acquisition starts using bolus tracking technique with 6 sec delay before monitoring starts and ROI in descending aorta with a threshold of 100 HU for automatic triggering.

Image reconstruction

From the raw data, 0.65 mm contiguous axial images are reconstructed in multiple phases of the cardiac cycle and best diastole & systole segments are selected. Multiplanar reconstruction (MPR), curved MPR, maximum intensity projection (MIP) and Volume rendering technique (VRT) are created using these axial images as source using SYNGOVIA multi modality work station.

Image analysis

PLAIN

AGASTON scoring system was followed to quantify the amount of atherosclerotic coronary calcification.

Post contrast images

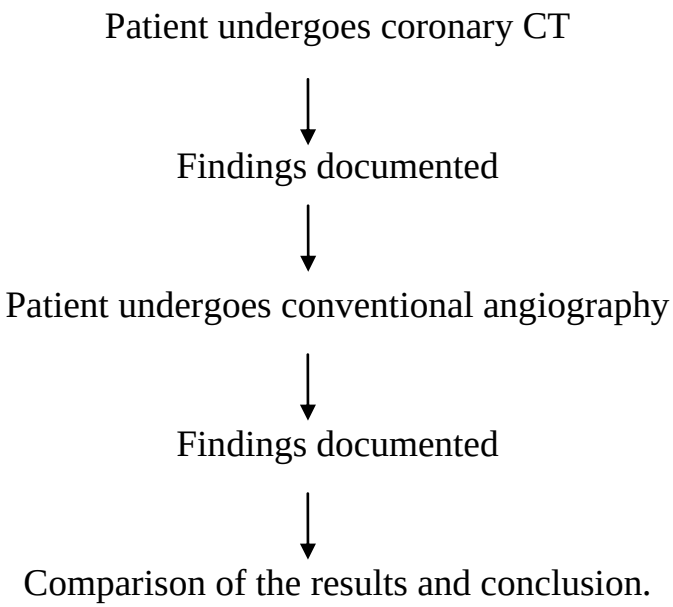
Post contrast axial, MPR, curved MPR, MIP and VRT images were used to analyze the vessel lumen, presence of any plaque and detection and quantification of stenosis if any.

Catheter angiogram was done after 1-2 weeks of CTCA. Catheter angiogram was performed by well trained and experienced cardiologist.

Considering catheter angiogram as gold standard the sensitivity, specificity, positive and negative predictive values of CTCA was evaluated.

In addition to the luminal diameter of vessels, dominance of the coronary circulation anatomical variation if any and calcium score was also noted.

STUDY DESIGN



REVIEW OF LITERATURE

REVIEW OF LITERATURE

ANATOMY

CORONARY ARTERY

Coronary artery is a vasa vasorum that supplies the heart**.**

The coronary artery arises just superior to the aortic valve and supply the heart

The aortic valve has three cusps –

1. Left coronary cusp
2. Right coronary cusp
3. non-coronary cusp

FIG 1 origin of vessels

Right coronary artery

Arises from right coronary cusp.

Courses to the inferior part of septum through the right atrio-ventricular groove

Branches

- Conus branch – 1st branch supplies the RVOT
- Sinus node artery – 2nd branch - SA node
- Acute marginal arteries-Arise at acute angle and runs along the margin of the right ventricle above the diaphragm.
- Posterolateral ventricular branch
- Posterior descending artery :

Area of distribution:

1) Right atrium

2) Ventricles

i) Greater part of right Ventricle except the area adjoining the anterior IV groove.

ii) A small part of the left ventricle adjoining posterior IV groove.

3) Posterior part of the IV septum

4) Whole of the conducting system of the heart, except part of the left br of AV bundle

Left coronary artery

Arises from left coronary cusps

Travels between RVOT anteriorly and left atrium posteriorly.

Almost immediately bifurcate into LAD and LCx

Length – 10-15mm

Left anterior descending artery (LAD):

The LAD courses till the apex through the inter ventricular groove anteriorly.

Branches

1. Diagonal branches D1 and D2

2. Septal branch

3. Conus branch

Area of distribution

1. Septum in its anterior part through the septal branches

2. Left ventricle in its anterior part through the diagonal branches.

3. AV-bundle.

Left circumflex artery (LCx)

LCx lies in between the left atrium and ventricle in the atrio-ventricular groove

Branches

1. Obtuse marginal branches (OM1 and OM2)

2. Ventricular branches

3. Atrial rami

Area of distribution

Lateral wall of the left ventricle.

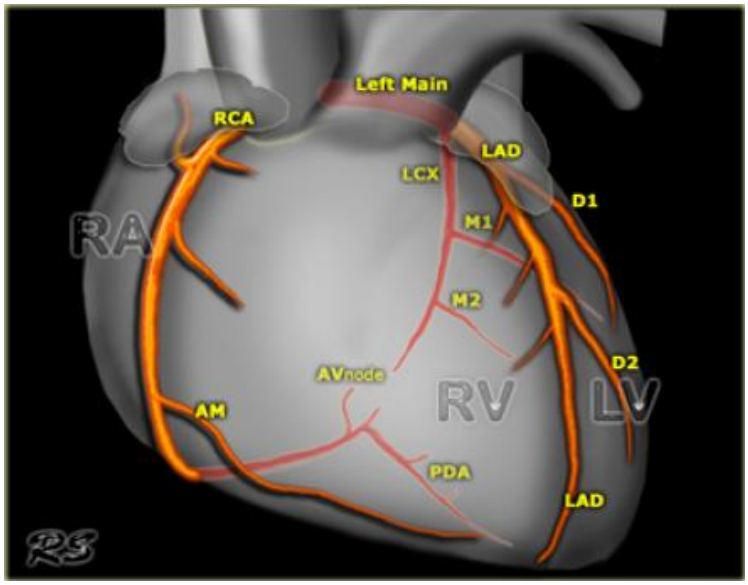


FIG 2 coronary vessels and its branches

Ramus intermedius

In few cases there is one more vessel arising in between LAD and LCx know as the ramus intermedius which acts as a diagonal branch of the LCx.

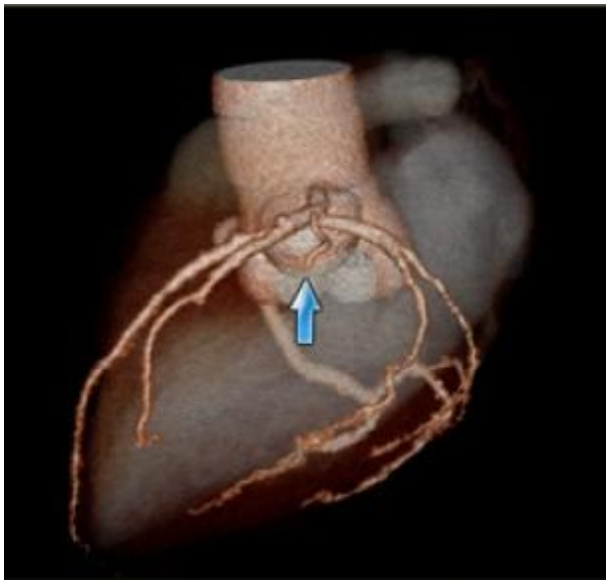


FIG 3 ramus intermedius vessel

Common vessel anomalies

1. Left anterior descending and Left circumflex originating from separate ostia
2. Left anterior descending origin from right sinus instead of left.
3. Right coronary artery origin from the sinus or from aortic wall
4. Right coronary artery origin from left sinus
5. Left main coronary artery origin from right sinus

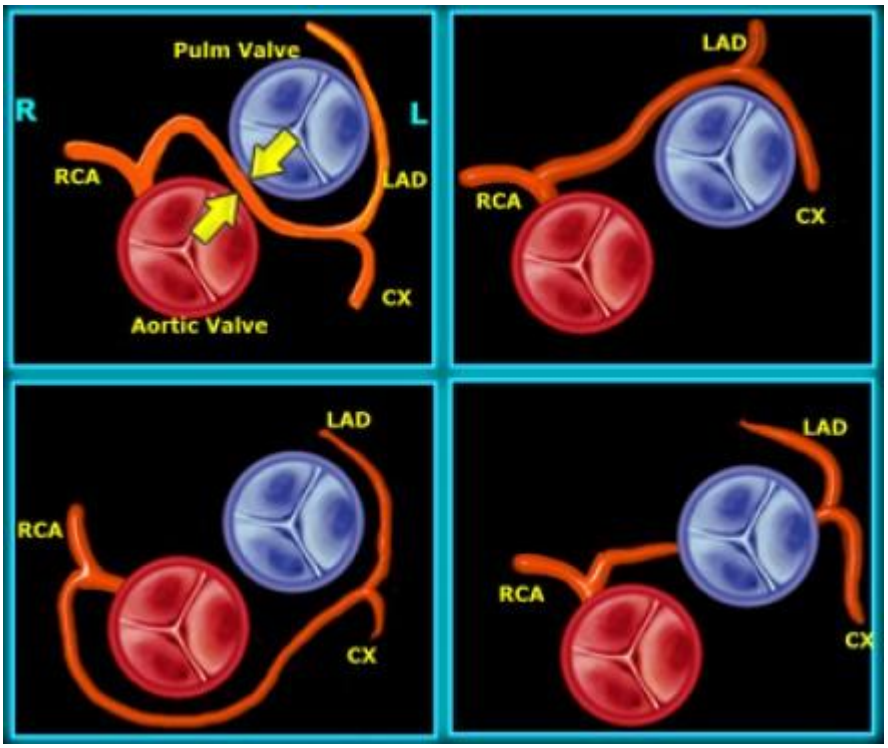
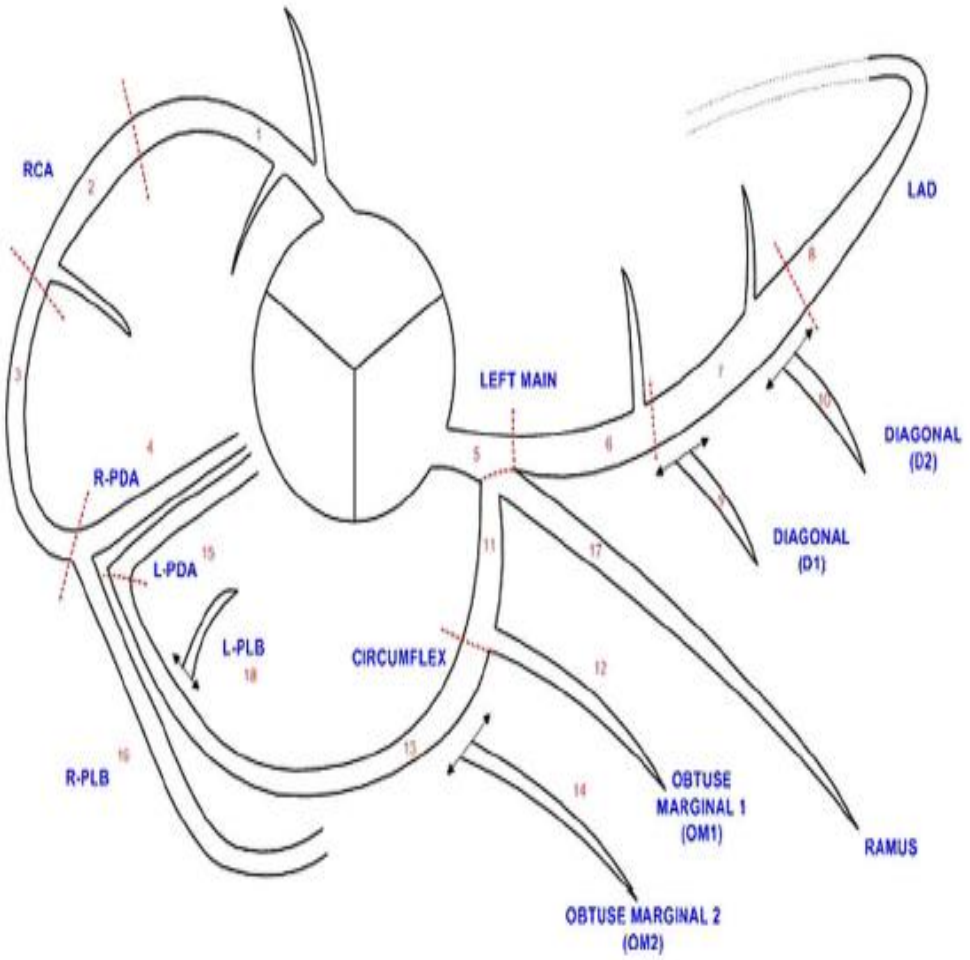


FIG 4 anatomical variations in origin

Dominance

Coronary circulation dominance can be either right dominant or left dominant or co-dominant based on the vessel which gives rise to posterior descending artery and poster lateral ventricular branch. The system is right dominant if PDA and PLVB arise from right coronary artery. Similarly if PDA and PLVB arises from left circumflex then it is said left dominant. If PDA arises from RCA and PLVB from LCx then it is co dominant.[13]

Fig 5. Segmentation of coronary vessels



According to Society of cardiovascular computed tomography [SCCT] guidelines 2009 [7] for the interpretation and reporting of Coronary computed topographic angiography the coronary arteries are divided into 18 segments for standard reporting and communication.

Table 1 Segmentation of coronary vessels

Segment 1	Proximal RCA
Segment 2	Mid RCA
Segment 3	Distal RCA
Segment 4	Right PDA
Segment 5	LMA
Segment 6	Proximal LAD
Segment 7	Mid LAD
Segment 8	Distal LAD
Segment 9	Diagonal 1
Segment 10	Diagonal 2
Segment 11	Proximal Lcx
Segment 12	OM1
Segment 13	Distal Lcx
Segment 14	OM2
Segment 15	Left PDA
Segment 16	Right PLB
Segment 17	Ramus
Segment 18	Left PLB

According to Society of cardiovascular computed tomography guidelines 2009[7] for the interpretation and reporting of CT coronary angiography the recommended quantitative and qualitative grading are as follows

Recommended Quantitative Stenosis Grading

0	Normal: Absence of plaque and no luminal stenosis
1	Minimal: Plaque with less than 25% stenosis
2	Mild: 25%–49% stenosis
3	Moderate: 50%–69% stenosis
4	Severe: 70%–99% stenosis
5	Occluded

Recommended Qualitative Stenosis Grading

0 Normal: Absence of

1 Minimal: Plaque with negligible impact on lumen

2 Mild: Plaque with no flow-limiting stenosis

3 Moderate: Plaque with possible flow-limiting disease

4 Severe: Plaque with probable flow-limiting disease

5 Occluded

Alexander W. Leber et al [1] studied the likelihood of CAD in intermediate risk group using CT coronary angiography. The study assessed the coronary status in intermediate risk group using dual X-ray source MDCT coronary angiography .In this study 90 patients were included out of which diagnostic quality was obtained only in 88 patients. CT angiography was compared with catheter angiography. Catheter angiography showed 18 stenosis which were more than 75 % and twenty four stenosis which were 50-75%. These results were compared with CT angiography. Out of 18 stenosis which were more than 75% 17 were correctly identified and one was underestimated. Out of twenty-four stenosis ranging from 50 to 75%, 17 were correctly graded. Five were overestimated, and three was underestimated. The study showed good correlation between dual source CT and catheter angiography with a slight tendency to overestimate the degree of stenosis. The study showed MDCT can accurately rule out coronary stenosis in intermediate risk group independent of heart rate.

Nico R. Mollet et al [2] studied the role of CT coronary angiography in 52 patients presenting with atypical chest pain, stable or unstable angina pectoris, or non–ST-segment elevation myocardial infarction. Patients with stable sinus rhythm and heart rate less than 70 were included in the study. Patients with heart rate more than 70 were given beta blockers. Patients underwent both CT and catheter angiography. Catheter angiography was taken as standard. CT scans were analyzed by two observers. Stenosis of more than 50% was considered as significant stenosis. Significant coronary stenoses were detected with 99%sensitivity and 95% specificity in comparison with catheter angiography. Except for one patient, all other angiographically normal patients were correctly identified. The study concluded that reliability of CT is high for identifying non significant coronary obstruction. Further patients with significant disease were also correctly diagnosed, except for one case. The study showed good correlation between CT and catheter angiography in the classification of patients having no stenosis or with stenosis.

Stephan Achenbach et al [3] studied the applicability and quality of CT coronary angiogram. Twenty five patients were included in this study in whom catheter angiography was done and significant stenosis was ruled out. Retrospective ECG gating was used for acquisition and images were reconstructed. CT angiography was used to determine the vessel length, contrast-to-noise ratio, and the diameter correlation between CT and catheter angiography. This study concluded that 78% of the vessels were visualized free of motion artifacts; vessel diameters in CT showed good correlation to quantitative catheter angiography. The mean contrast-to-noise ratio was 9.3. They also studied the cardiac phase within yielded optimal image quality, which showed that it varies with patients and different vessels. Optimal image quality was achieved for LMA and LAD in 70% or 80% of the cardiac cycle and 50% for RCA and LCx.

Gilbert L. Raff et al [4] studied the diagnostic accuracy of CT coronary angiography using 64 slice CT scanner. Study included a total of 70 patients who underwent both CT and coronary angiography. Patients with atrial fibrillation, high calcium score and obese patients were excluded front the study. All vessels including those with 1.5mm diameter were analyzed for any lesions..These lesions were compared quantitatively and qualitatively with catheter angiography for each vessel and each segment. Sensitivity, specificity, PPV and NPV for significant stenosis were calculated. Negative predictive value for significant stenosis was 97% . Positive predictive value was 66%. Sensitivity and specificity was 86% and 96% respectively. Sensitivity, specificity, PPV and NPV for artery was calculated which was 91%, 92%, 80%, and 97%, respectively and for patients 95%, 90%, 93%, and 93%, respectively. The effect of calcium score on CT accuracy was analyzed. Results demonstrated that high accuracy was there when calcium score was low and moderate but when AGASTON score was more than 401 there was reduced specificity and negative predictive value. Influence of obesity on accuracy of CT coronary angiography was studied which showed that obesity has significant influent on the accuracy. Also influence of heart rate on multi-detector CT coronary angiography accuracy was studied. When heart rate was within seventy

beats/min there was better accuracy but heart rate of more than 70bpm showed declining sensitivity specificity positive predictive value and negative predictive value (sensitivity declining to 88%, specificity to 71%, PPV to 78%, and NPV to 83%).

Sebastian Leschka et al [5]studied the accuracy of 64 slice multi-detector computed tomography coronary angiography in comparison with catheter angiography. Sixty seven patients with suspected CAD were included in this study and the results were compared with catheter angiography. All vessels were included for the assessing significant stenosis Image quality was graded as excellent, good and adequate and were sixty-one percent, thirty one percent and eight percent respectively and best results were obtained in the proximal coronary arteries. None of the vessel segment was excluded from analysis. Thirty six percent of the forty nine percent calcified vessels had massive calcification causing beam hardening artifacts and impairing the image quality. The overall sensitivity, specificity, PPV and NPV were calculated which were 94%,97%.87% and 99% respectively. Three stenosis were missed due to motion artifact. Patients without coronary artery disease were correctly identified by CT. The study concluded that CT coronary angiography provided high diagnostic accuracy for assessing coronary stenosis.

OBSERVATION AND RESULTS

In this study a total of 20 patients were included. Catheter angiogram detected 41 stenoses. Out of which 36 were detected by CT coronary angiogram and 5 lesions were missed. Three stenosis which were not detected by conventional angiogram were detected by CT.

Table 2: Age wise distribution of study group

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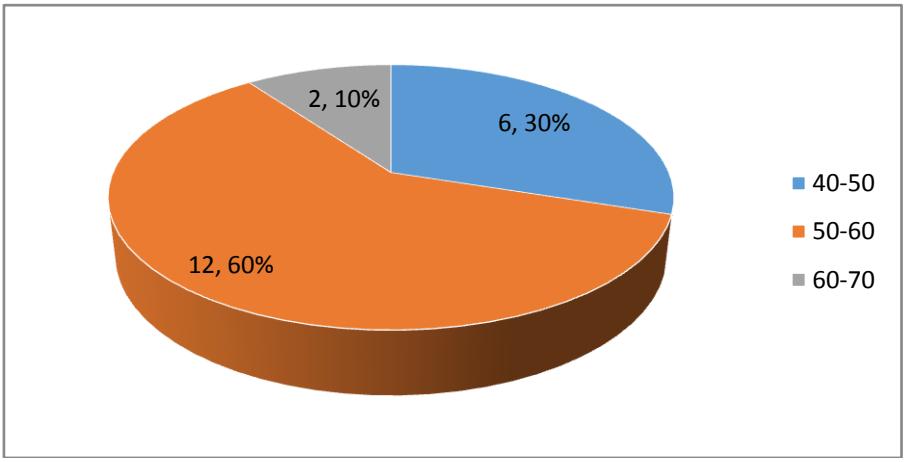
Age Group	Frequency	Percentage
40-50	6	30
50-60	12	60
60-70	2	10
Total	20	100

Fig 6: Age wise distribution of study group

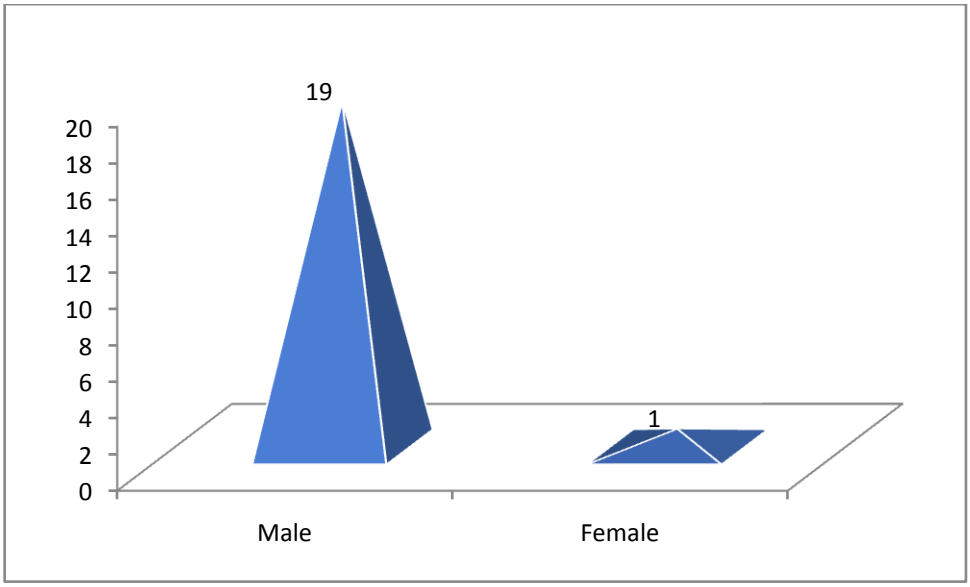


In our study group the mean age was 52.8 with a standard deviation of 7.516.

Table 3: Sex wise distribution:

Sex	Frequency	Percent
Male	19	95
Female	1	5
Total	20	100

Fig 7. Sex wise distribution

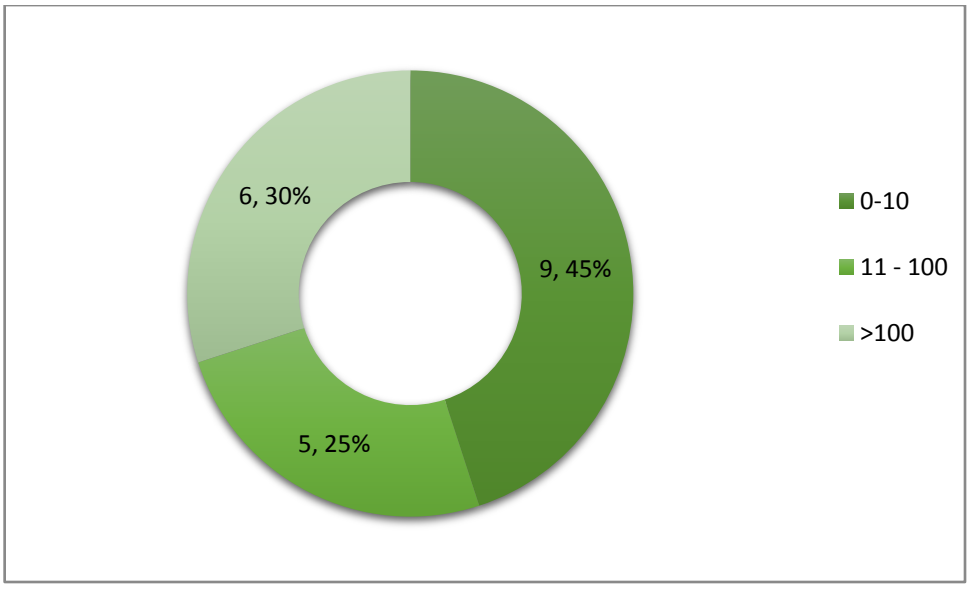


In our study group of 20 patients 19 were male and one was female.

Table 4:Calcium scoring

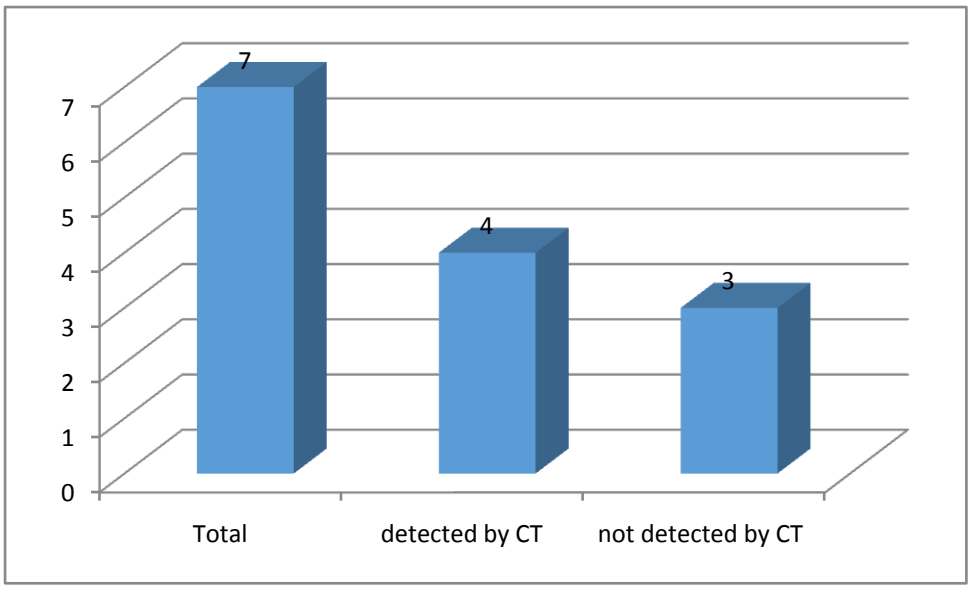
Score	Frequency	Percentage
0-10	9	45
11 - 100	5	25
100-400	6	30
Total	20	100

Fig 8. Calcification



In our study population the mean calcium scoring was 85.825 with a standard deviation of 135.5271

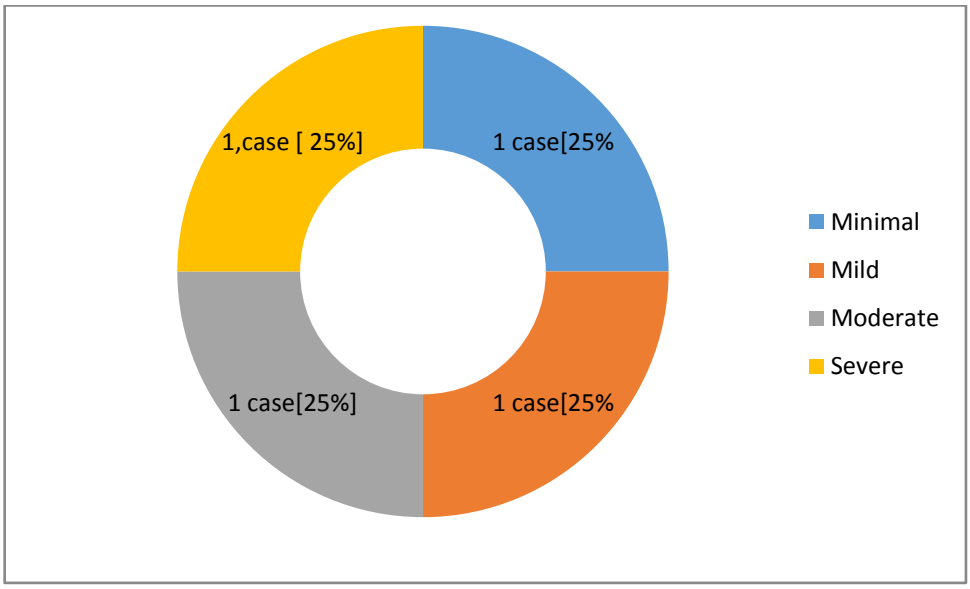
Fig 9:CT Vs Cath in detecting minimal stenosis (<20%)



A total of 7 minimal stenosis was detected by catheter angiogram. In this study 4 was detected by CT, 3 were not detected.

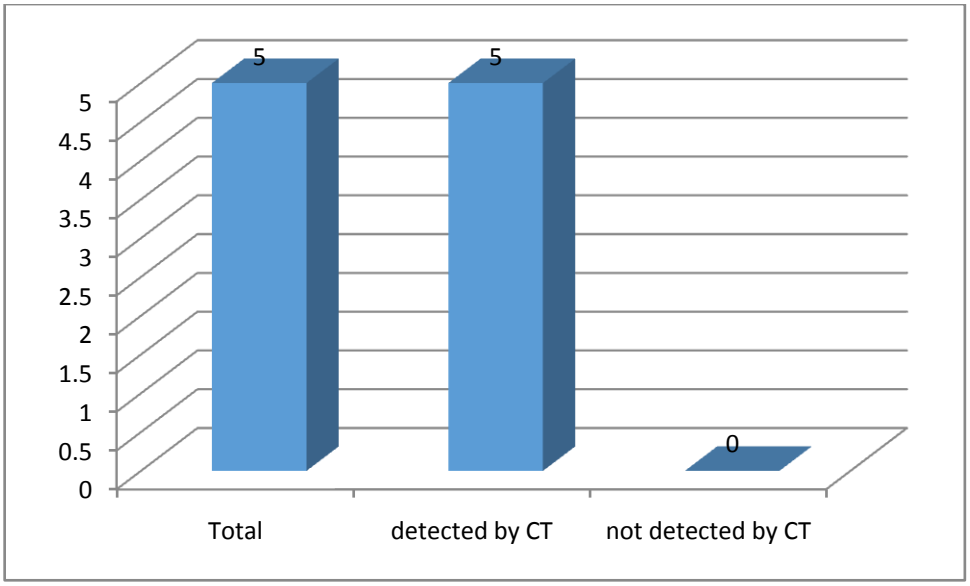
Fig 10: Grading correlation between CT & CATH ANGIO for minimal stenosis

CT grading for the four cases of minimal stenosis diagnosed in CATH ANGIO



A total of 7 minimal stenosis was detected by catheter angiogram. In this study 4 was detected by CT and 3 were not detected. In four minimal stenosis detected in CT only one was graded as minimal stenosis.

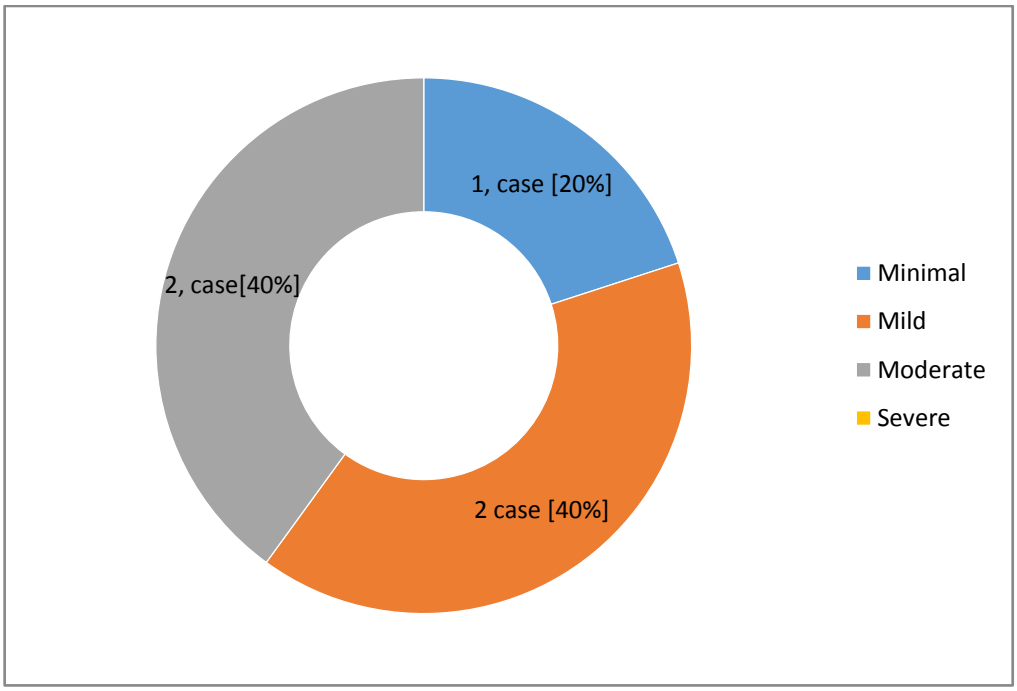
Fig 11.CT Vs Cath in detecting mild stenosis



A total of 5 mild stenosis was detected by catheter angiogram. CT coronary angiogram detected all the five mild stenosis accurately.

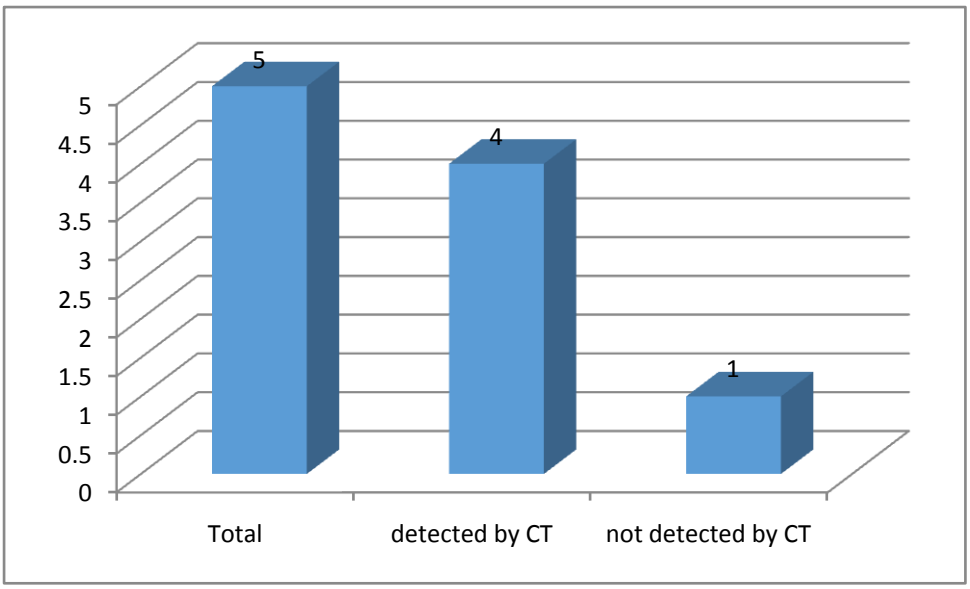
Fig12: Grading correlation between CT & CATH ANGIO for mild stenosis

CT grading for the five cases of mild stenosis diagnosed in CATH ANGIO



In this study five mild stenosis were detected in CT and only two were correctly graded as mild stenosis

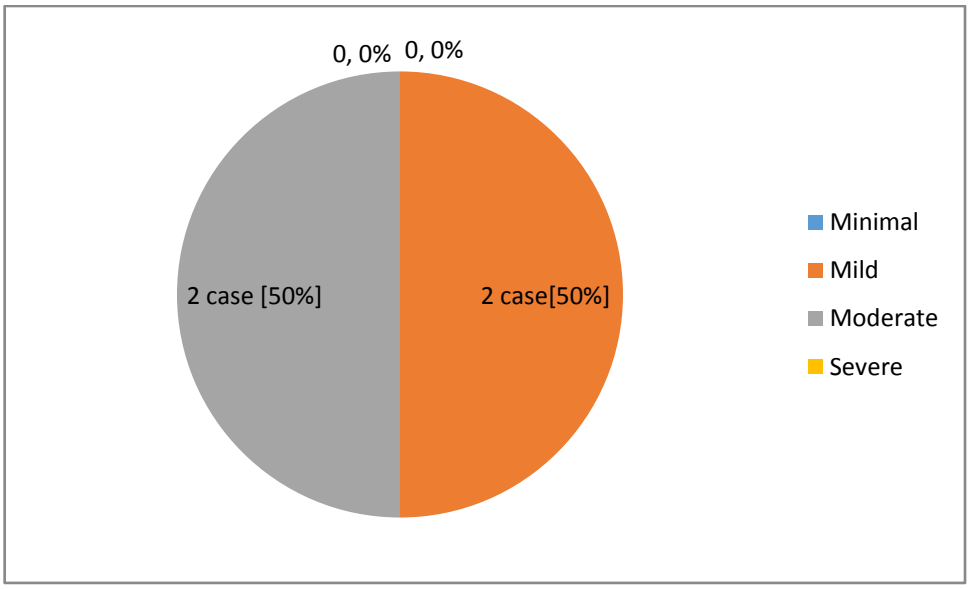
Fig 13.CT Vs Cath in detecting moderate stenosis:



Totally there were 5 moderate stenosis detected in catheter angiogram. Out of this 5 stenosis 4 were accurately detected by CT angiogram and 1 was not detected.

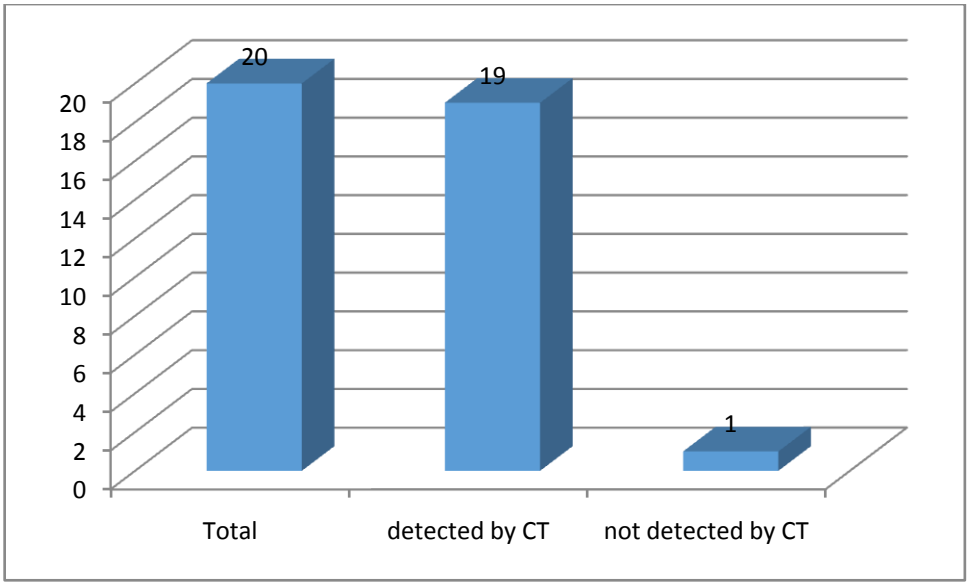
Fig. 14 Grading correlation between CT & CATH ANGIO for moderate stenosis

CT grading for the four cases of moderate stenosis diagnosed in CATH ANGIO



Out of four moderate stenosis detected in CT, two were correctly graded as moderate stenosis.

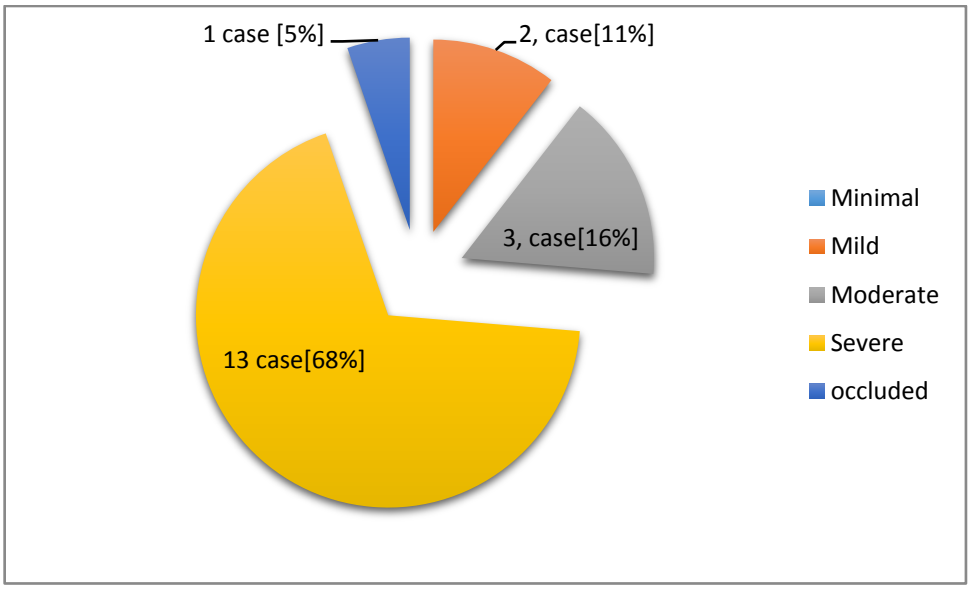
Fig 15 CT Vs Cath in detecting severe stenosis



A total of 20 severe stenosis were detected in catheter angiogram. Nineteen cases were accurately detected in CT. One stenosis was not detected in CT due to poor filling of distal LAD.

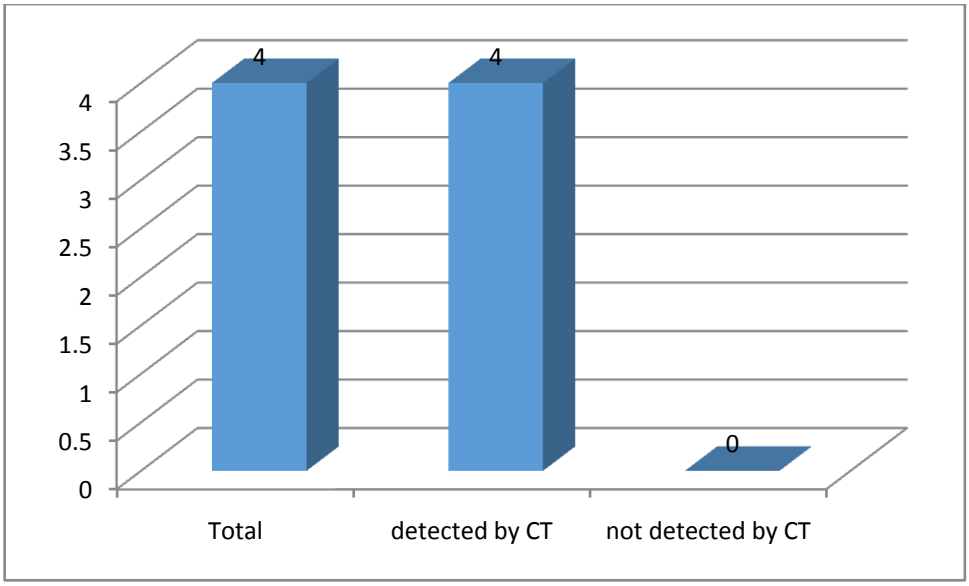
Fig 16 Grading correlation between CT & CATH ANGIO for severe stenosis

CT grading for the nineteen cases of severe stenosis diagnosed in CATH ANGIO



Out of 19 severe stenosis detected in CT, 13 were correctly graded as severe stenosis which corresponds to 68 %

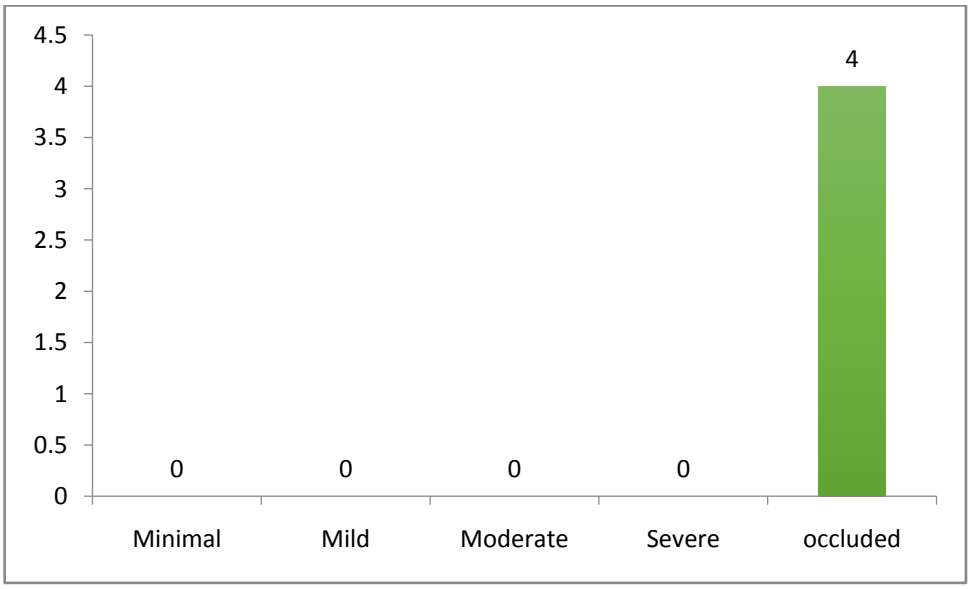
Fig 17 CT Vs Cath in detecting occlusion



Totally four occluded stenosis were detected both in catheter angiogram and CT coronary angiogram.

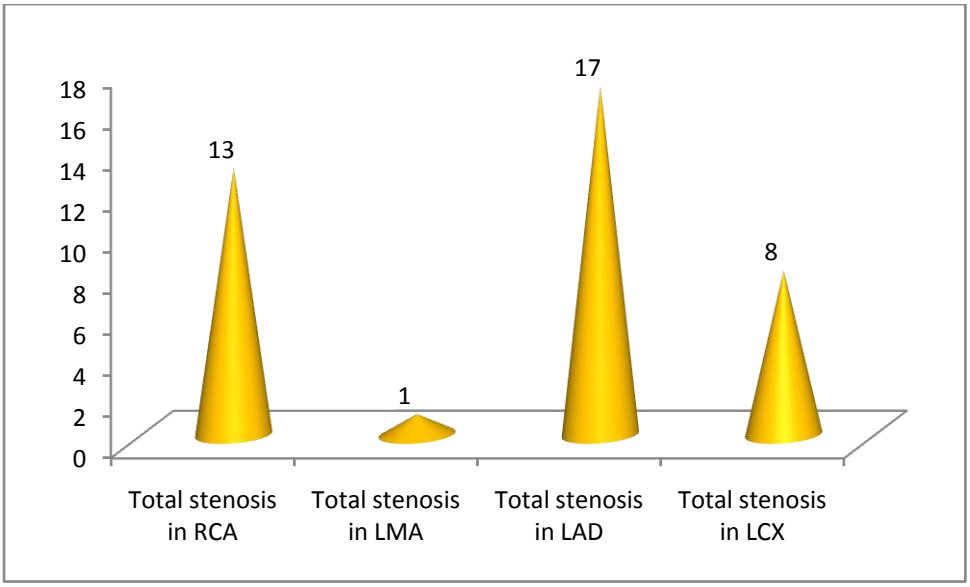
Fig 18 Grading correlation between CT & CATH ANGIO for occlusion

CT GRADING for the four cases of occlusion diagnosed in CATH ANGIO



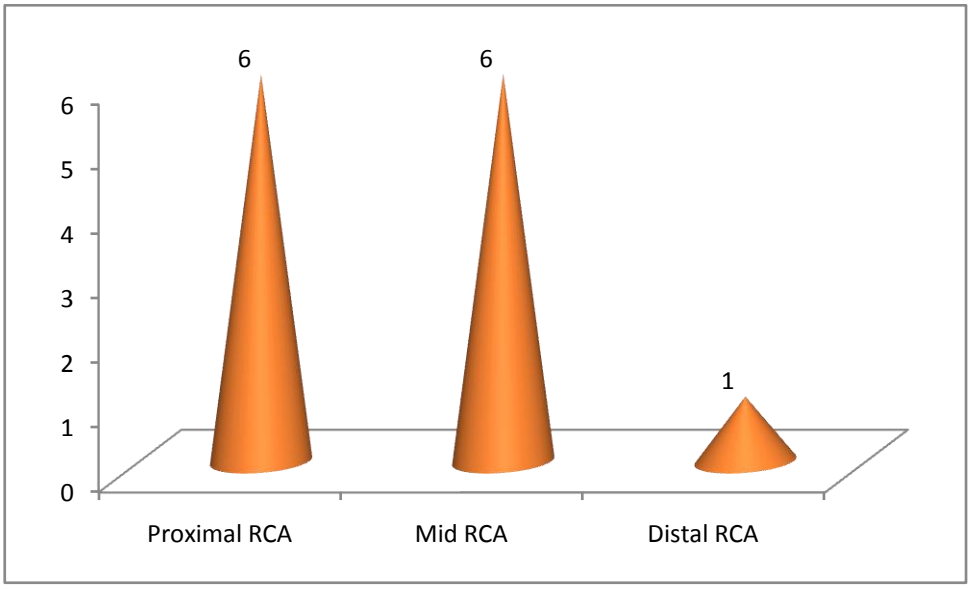
All the four were correctly graded as total occlusion.

Fig 19 Vessel wise distribution of the stenosis



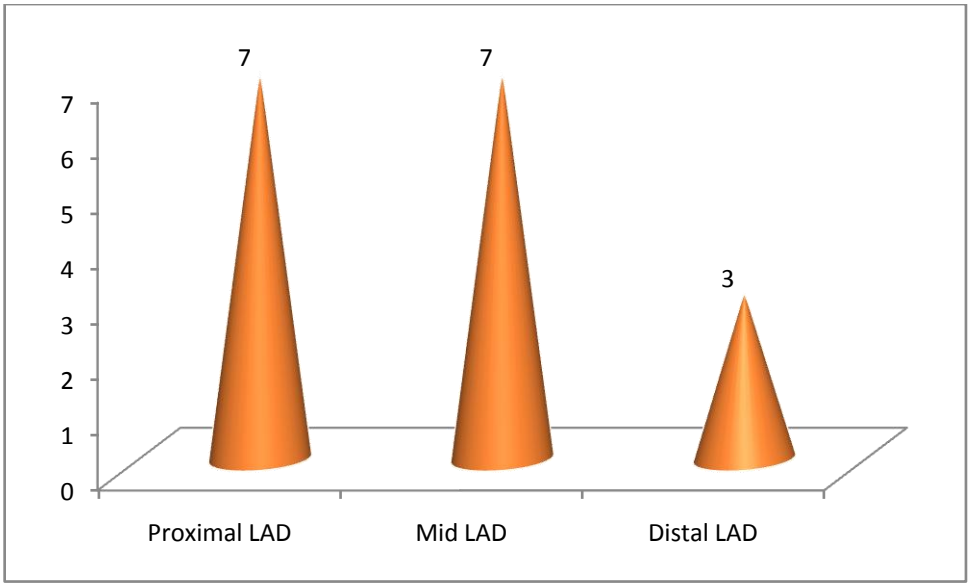
On comparing the stenosis vessel wise, maximal involvement was seen in LAD followed by RCA. The least involved vessel was left main coronary.

Fig 20Segment wise distribution of stenosis in RCA



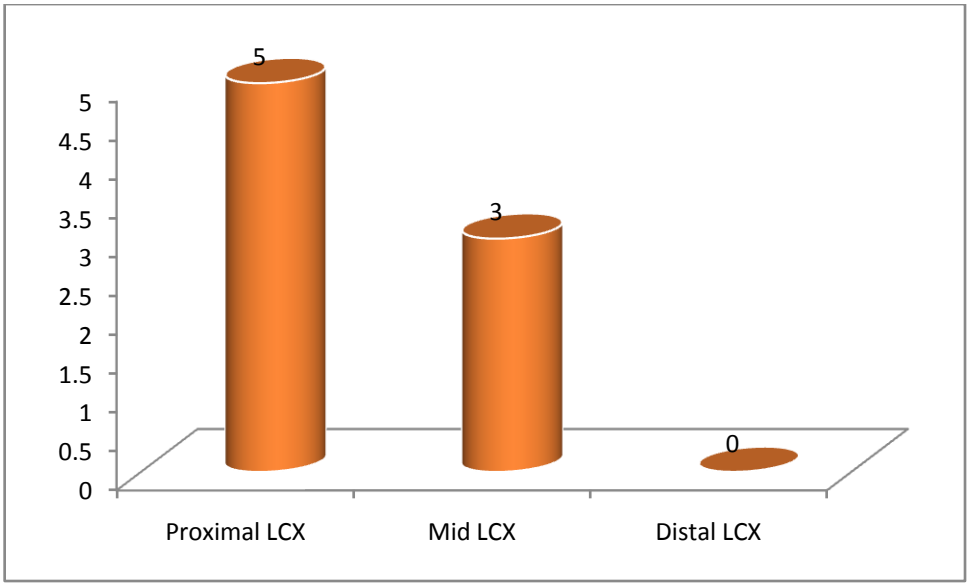
On comparing the segment wise involvement in right coronary artery distal RCA was least affected.

Fig 21Segment wise distribution of stenosis in LAD



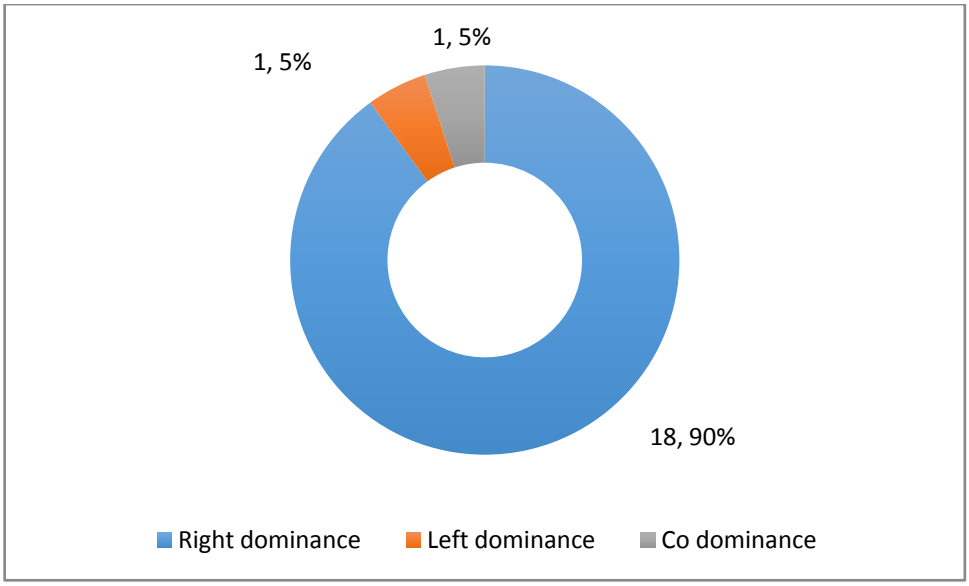
On comparing the segment wise involvement in left coronary artery distal LAD was least affected. The distribution was same in proximal and mid LAD.

Fig 22 Segment wise distribution of stenosis in LCx



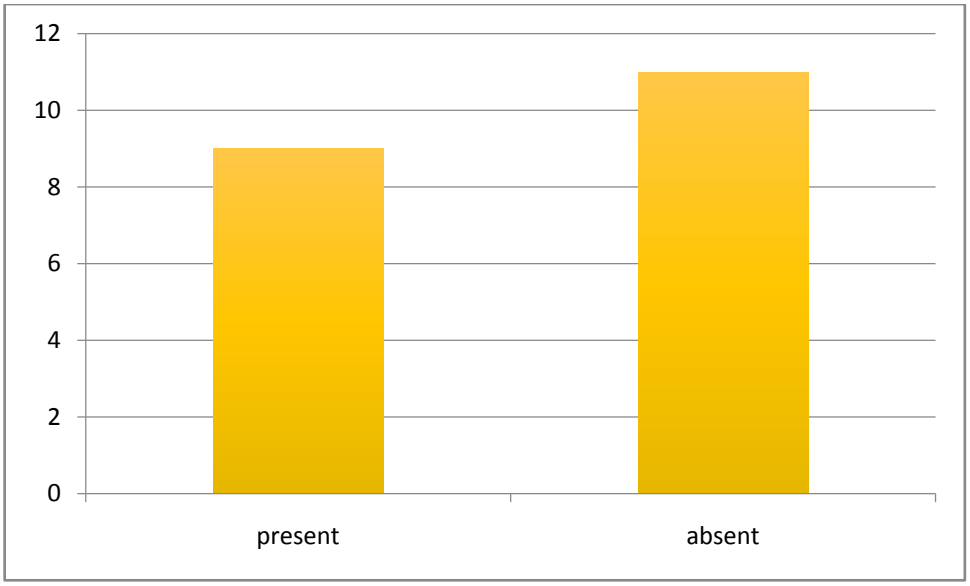
On comparing the segment wise involvement in left circumflex, proximal LCx was involved in 5 out of 8 cases.

Fig 23 Dominance



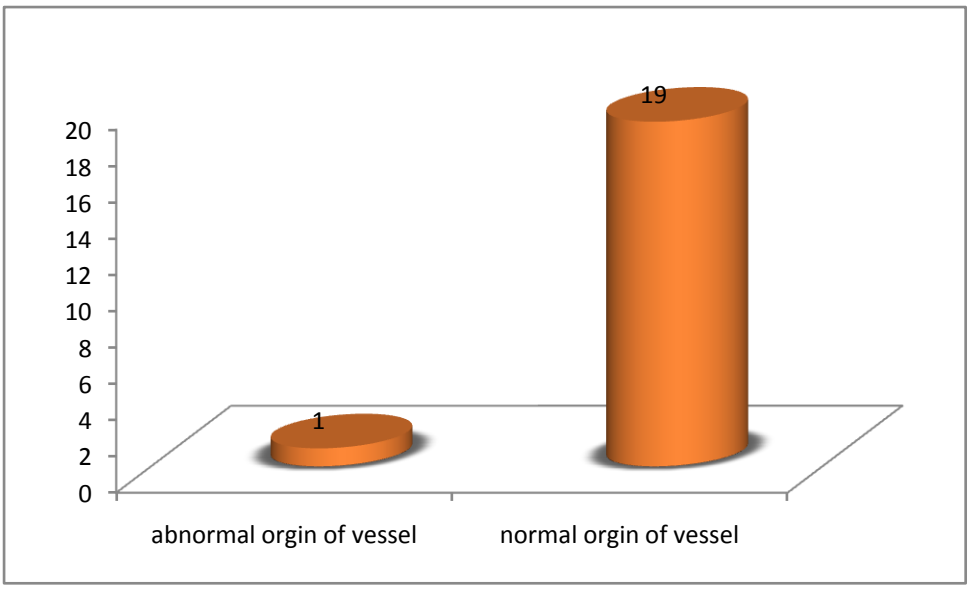
Out of 20 cases included in the study 18 cases which is 90 percent had right circulation. One case was left dominant and the other one was co dominant.

Fig 24 Presence of ramus intermedius



Ramus intermedius was present in 9 out of twenty cases.

Fig 25 Number of vessels with anomalous origin



In one patient the left main coronary artery was seen arising from right coronary cusp

Table 5 Segmental luminal diameter of RCA

RCA(mm)	Proximal	MID	DISTAL
1.0-2.0	6	8	14
2.0-3.0	12	10	5
3.0-4.0	2	2	1

Fig 26 Segmental luminal diameter of RCA

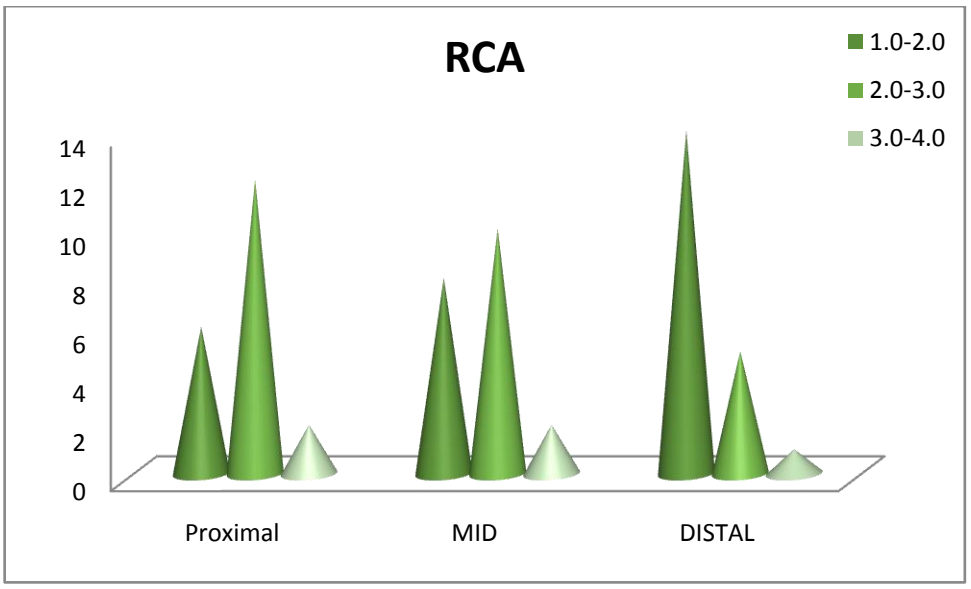


Table 6 Segmental luminal diameter of LAD

LAD(mm)	Proximal	MID	DISTAL
1.0-2.0	4	14	18
2.0-3.0	7	6	2
3.0-4.0	2		

Fig 27 Segmental luminal diameter of LAD

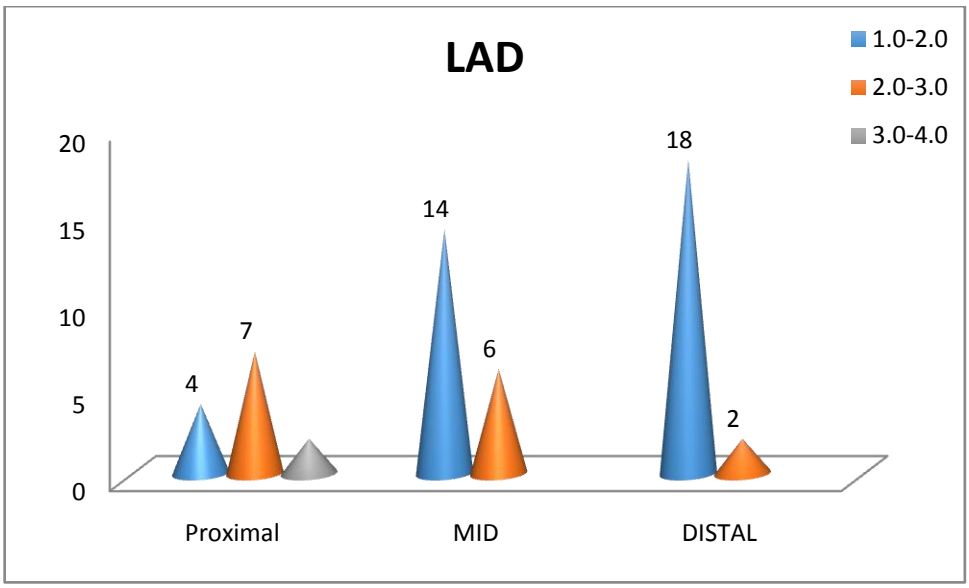


Table 7 Segmental luminal diameter of LCx

LCX(mm)	Proximal	MID	DISTAL
1.0-2.0	10	14	17
2.0-3.0	8	5	3
3.0-4.0	2	1	

Fig 28 Segmental luminal diameter of LCx

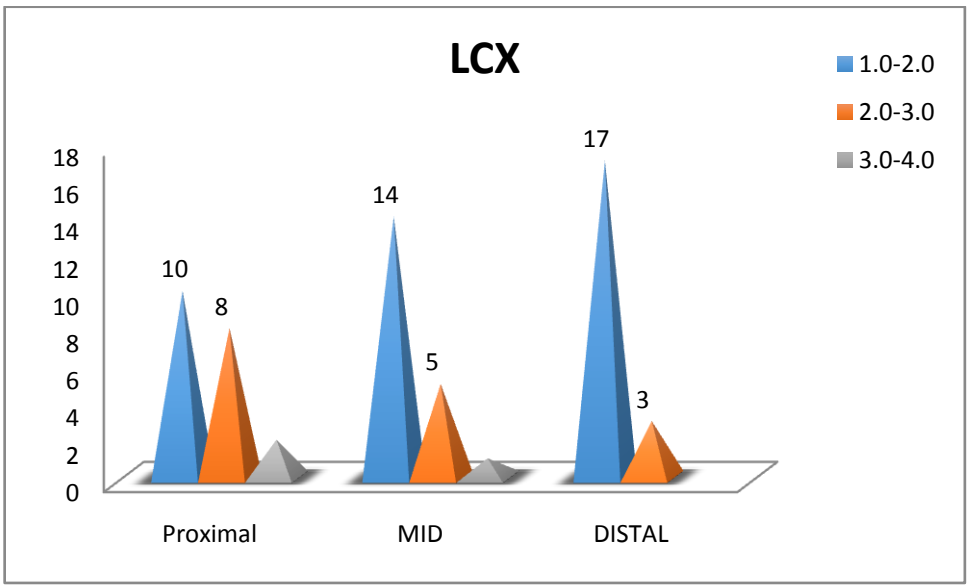


Fig 29 Segmental luminal diameter of LMA

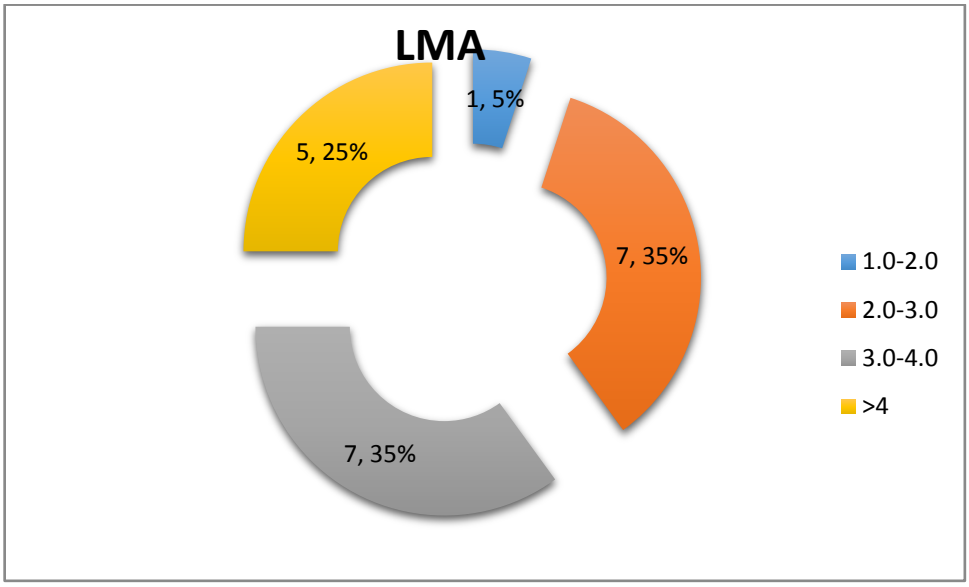


Table 8 Comparison of CT with cath angio in detecting all stenosis

CATH Detected			
	Stenotic Segments	Normal Segments	Total
CT positive	36	3	39
CT negative	5	139	144
Total	41	142	183

Sensitivity	87.80%
Specificity	97.90%
PPV	92.30%
NPV	96.50%
p value	<0.05 , significant

Table 9 Comparison of CT with cath angio in detecting clinically significant stenosis

CATH Detected			
	Stenotic Segments	Normal Segments	Total
CT positive	27	3	30
CT negative	2	151	153
Total	29	154	183

Sensitivity	93.00%
Specificity	98.00%
PPV	90.00%
NPV	98.70%
P value	<0.05, significant

Correlation between CT Angiogram Grading with CATH angiogram grading

Minimal stenosis:	25%
Mild stenosis:	40%
Moderate stenosis:	40%
Severe stenosis:	68%
Occluded:	100%

DISCUSSION

Our study was conducted in 20 patients. All these twenty patients underwent both CT coronary angiogram and catheter angiogram. Results of CT coronary angiogram were compared with catheter angiogram. First calcium scoring was done for each case. Patients with calcium score of more than 600 were excluded from the study. All the vessels were analyzed on segment to segment basis for any stenosis and if there was any stenosis they were graded accordingly.

Our study included patients from 40 to 70 years of age. The mean age in this group was 52.8. In a total of 20 patients, 12 patients were 50-60 years. Only 10 percentages of the patients were in 60-70 years of age group. Out of the 20 patients 19 were male and one was female.

Calcium scoring was done for each patient. AGASTON scoring was used as standard. Nine patients had calcium scoring of less than 10. Six patients had calcium scoring of more than 100. The mean calcium score in our study was 85.

A total of 41 stenosis were detected in catheter angiogram. CT detected accurately 36 stenosis, 5 were not detected. Out of these 5 cases three were less than 20 percent, one was less than 50 percent and

one was severe stenosis. The severe case which was undetected in CT was noted in the distal LAD segment which showed no filling of contrast. The overall sensitivity, specificity, positive predictive value and negative predictive value were 87.8, 97.9, 92.3 and 96.5 respectively [p value <0.05, significant]

Lesions which were more than 50% were considered as clinically significant A total of 29 clinically significant lesions were detected in catheter angiogram. Out of these 29 cases 27 cases were detected in CT angiogram. One case which was missed was due to non visualized distal LAD and the other case was due to myocardial bridging. The overall sensitivity, specificity, positive predictive value and negative predictive value were 93%, 98%, 90% and 98.7% for the clinically significant stenosis[p value <0.05, significant]

. Out of 4 totally occluded lesions detected in Catheter angiogram all the 4 were accurately detected in CT coronary angiogram. Sensitivity, specificity, positive and negative predictive value were all 100%

Total of 3 stenosis were detected in CT coronary angiogram which was not detected in catheter angiogram

The Percentage of CT grading correlating with catheter angiogram in this study is 1) minimal grading - 25%, 2) mild grading - 40%, 3) moderate grading - 40%, 5) severe grading - 68% and 6) occluded vessel - 100%

Luminal diameter of each segment was documented. The mean diameter of proximal, mid and distal RCA was 2.5, 2.3 and 2.0 mm respectively.

The mean diameter of proximal, mid and distal LAD was 2.5, 1.9 and 1.6mm respectively. The mean diameter of proximal, mid and distal LCx were 2.2,1.8 and 1.5mm respectively. The mean diameter of main left coronary artery was 4.0mm. According to the study done by G Y H Lip et al[6] which studied the coronary diameter in indo Asian population and Caucasians in catheter angiogram the mean left main coronary diameter was 3.98. Mean proximal, mid and distal LAD were 3.22, 2.77 and 2.26; mean proximal and distal LCx were 3.01 and 2.37 mm; proximal and distal RCA were 2.98 and 1.69. This study compared the diameter on Indo-Asian population with that of Caucasians and found that the Indo-Asian population has smaller luminal diameter on comparison with Caucasians. The diameter of coronary arteries in Indian population is comparable with the diameter of the coronay arteries in the G Y H Lip et al study group.

According to the study done by Nico R. Mollet et al [2]which studied the role of CT coronary angiography in 52 patients presenting with atypical chest pain, stable or unstable angina pectoris, or non–ST-segment elevation myocardial infarction with 64 slice MDCT significant coronary stenosis were detected with 99%sensitivity and 95% specificity 76% positive predictive value and 99% negative predictive value in comparison with catheter angiography. In our study the sensitivity, specificity, PPV and NPV for significant stenosis were 93%, 98%. 90% and 98% respectively.

According to the study done by Alexander W. Leber [1] et all there was 18 stenosis which were more than 75%. Out of this 18 stenosis 17 were detected accurately and one was underestimated. In our study there were totally 24 stenosis which were more than 75%. Out this 24 stenosis 23 were detected accurately detected and one was underestimated. The sensitivity and specificity of our study is concordant with this study. In this study there was 9 stenosis which was over estimated and in our study there was 3stenosis which was over estimated. According to this study the negative predictive value to exclude stenosis of more than 755 was 100% and in our study it was 98% which is concordant. Out of twenty-four stenosis ranging from 50 to 75%, 17 were correctly graded. Five were overestimated, and three

was underestimated. In our study percentage of CT grading correlating with catheter angiogram moderate grading was 40% (two out of 4 lesions). Two lesion was underestimated which is comparable with the study.

According to the study done by Stephan Achenbach et al [3]left main coronary artery was free of visible motion artifact in all cases which is in concordant with our study. In our study also there no motion artifact was encountered in left main coronary.

In the study done by Gilbert L. Raff et al in 70 patients the mean age group was 59 and in our study group the mean age group was. In this study the sensitivity, specificity, PPV and NPV were 97%, 95%, 97% and 95 % respectively. In our study sensitivity, specificity, PPV and NPV were 93%, 98%. 90% and 98% respectively which is comparable

SUMMARY

This was a prospective study in 20 patients who presented with typical/ atypical chest pain and in whom both CT and Catheter angiogram was done.

CT findings were compared with catheter angiogram findings

The study group included 19 male patients and one female patient with age group between 40 and 70 yrs.

Stenosis of more than 50% was considered as significant stenosis. Sensitivity, specificity, PPV and NPV for significant stenosis were 93%, 98%. 90% and 98% respectively in our study

Over all sensitivity, specificity, PPV and NPV for detecting stenosis in CT was. 87.8%, 97.9%, 92.3 %and 96.5% respectively.

CONCLUSION

CONCLUSION

1. CT can be used as a reliable method to quantify the calcium score.
2. CT coronary angiography is sensitive in detecting clinically significant stenosis provided the quality of the image is adequate
3. CTCA is an excellent tool to detect anatomical variants of coronary arteries.
4. CTCA has sensitivity, specificity, PPV and NPV of 93%, 98%. 90% and 98% respectively for detecting clinically significant stenosis
5. The overall sensitivity, specificity, PPV and NPV for detecting all the stenosis (including <50%) were 87.8%, 97.9%, 992.3% and 96.5% respectively.

LIMITATION & RECOMMENDATIONS

LIMITATIONS:

- Small study population, owing to difficulty in collecting patients who underwent both CT and catheter angiogram, as most of the patients are directly subjected to Catheter angiogram.
- Motion artifacts impaired the image quality and there by diagnostic accuracy of CT coronary angiography.
- Poor breath holding can lead to artifacts and affects the image quality and interpretation.
- CT has a tendency to over/ underestimate the degree of stenosis.

RECOMMENDATIONS:

We would propose that all cases of suspected coronary artery disease should undergo CT coronary angiogram so that catheter angiogram can be used only for therapeutic purpose.

CT coronary angiogram should be performed in cases of typical/atypical chest pain.

CT coronary angiogram should be performed in mild to intermediate risk groups of having coronary disease.

CT coronary angiogram is first hand tool for diagnosing anatomical variations.

IMAGES

FIG.30 reconstructed MIP image showing normal RCA

Fig.31 reconstructed MIP image showing normal LAD

Fig.32 reconstructed MIP image showing normal LCx

Fig.33 catheter angiogram image of normal RCA

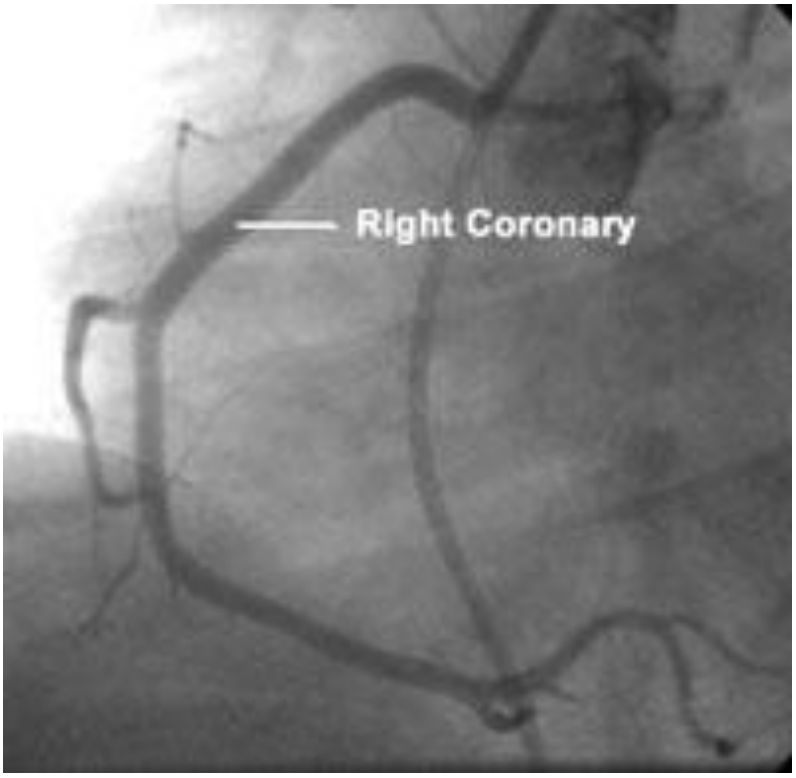


Fig.34 catheter angiogram image of normal LAD and LCx

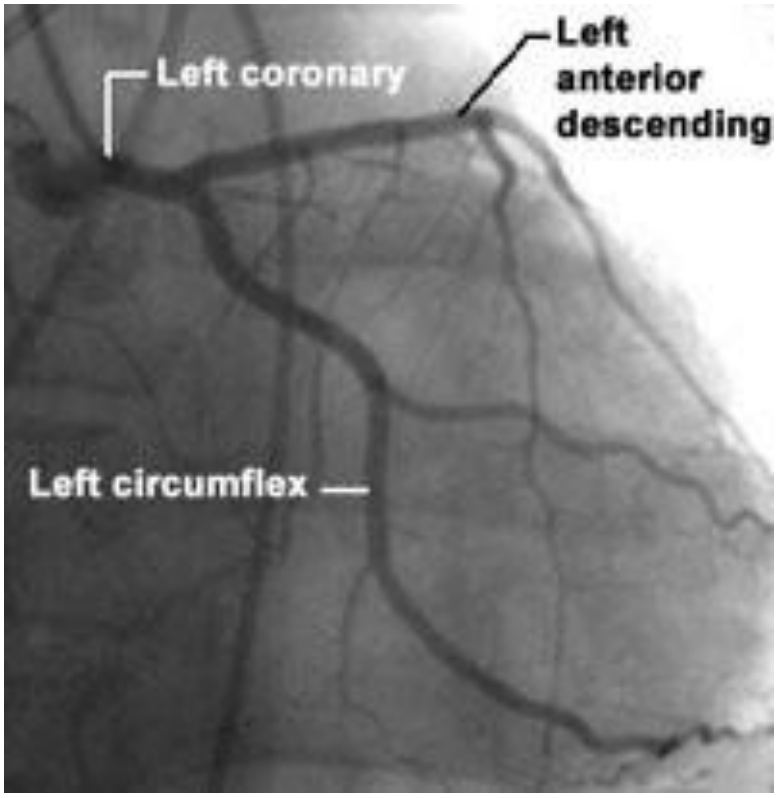


Fig.35 catheter angiogram and CT image of RCA showing severe stenosis in the distal segment

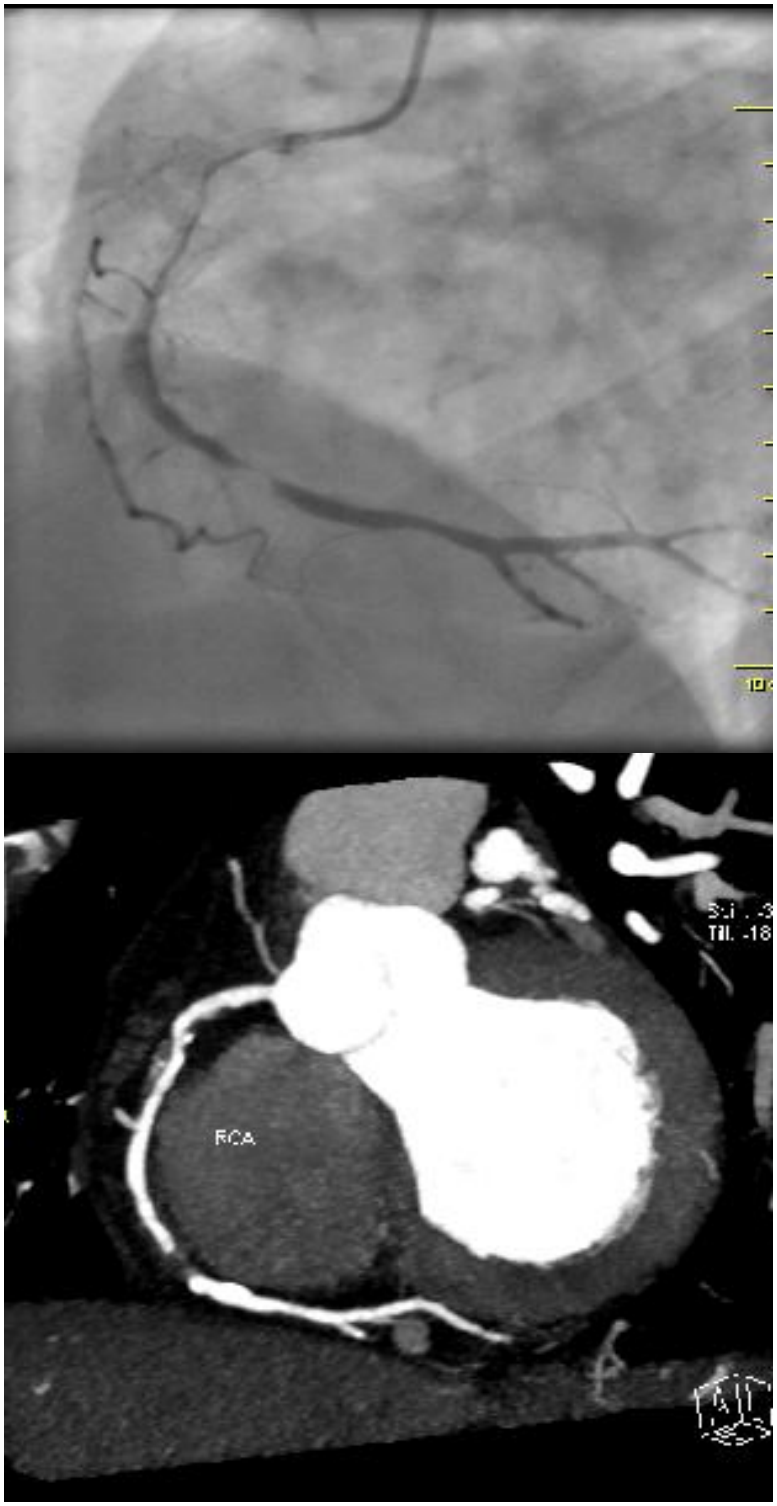
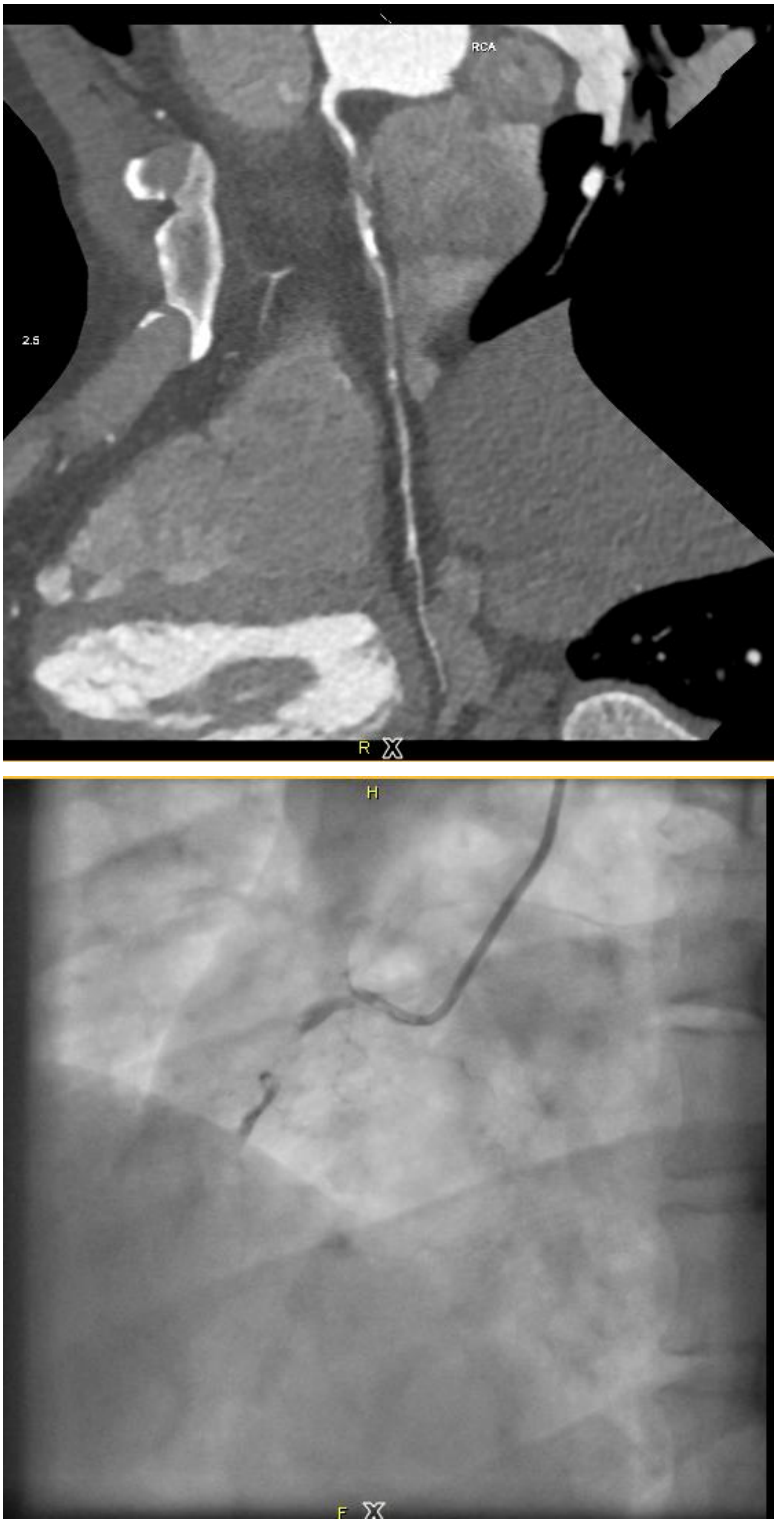


Fig.36 catheter angiogram and CT image of LCx showing stenosis in proximal segment

Fig.37 catheter angiogram and CT image of RCA showing total occlusion in proximal segment



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ANNEXURE:

LIST OF TABLES:

LIST OF FIGURES

MASTER CHART

S.no	RCA Dia (mm)			LMA Dia (mm)	LAD Dia(mm)			LCX Dia(mm)		
	Proximal	Mid	Distal		Proximal	Mid	Distal	Proximal	Mid	Distal
1	4	3.5	2	5	3	2.3	1.7	3	2.4	1.6
2	1.8	3	2	3	3	1.9	1.6	1.9	1.7	1.2
3	2.2	2.2	2	5	2.5	2.2	1.7	2	1.4	1.4
4	2.2	1.9	1.8	2.4	2.1	1.5	1.5	1.4	1	0.9
5	2	2.5	2.5	2.5	2.2	2	1.6	1.9	1.6	1.6
6	2.2	2	1.6	4	1.8	1.6	1.4	2.2	1.8	1.6
7	3	2.7	2.7	4	2.1	1.5	1.4	2.4	1.5	1
8	3	2	1.5	3	2.5	1.7	1.6	2	1.5	1.3
9	2	2	2	16	2	1.6	1.3	2.2	1.8	1.4
10	3	2.4	2.3	5	3.7	2.5	2.2	2.7	1.5	1.6
11	3.7	3.7	3.5	3.5	4	2.7	2.2	3.2	2.2	1.5
12	3	3	3	3.5	3	1.5	1.5	1.8	1.7	1.5
13	3	2.2	1.5	1.2	2	1.4	1.5	2.5	2.5	2.4
14	2.5	2.1	1.8	2.5	2.2	1.7	1.5	2	2	1.6
15	2.5	1.5	1.5	3.5	2.4	2.4	1.5	2.7	2.2	2.1
16	2	1.8	1.6	2.5	2.5	1.9	1.7	2.2	2.2	1.6
17	2.5	2.5	2	5	3	2.5	2	3.4	3.1	2.1
18	2	1.7	1.2	3.5	2	1.8	1.4	2	1.5	1.3
19	1.8	2	2	2.8	2.6	2	1.6	1.5	1.3	1
20	2.5	2.2	2.2	3.4	2.3	1.8	1.7	1.9	1.8	1.5
	2.545	2.345	2.035	4.065	2.545	1.925	1.63	2.245	1.835	1.51

S.no	RCA				LMA				LAD				LCx			
	Detection of stenosis		Grading of Stenosis		Detection of stenosis		Grading of Stenosis		Detection of stenosis		Grading of Stenosis		Detection of stenosis		Grading of Stenosis	
	CT	CATH		CATH	CT	CATH	CT	CATH	CT	CATH	CT	CATH	CT	CATH	CT	CATH
1	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
2	1. Proximal RCA+ 2. Mid RCA + 3. Distal RCA +	1. + 2. + 3. +	1. Severe 2. Minimal 3. Severe	1. Minimal 2. Mild 3. Severe	N	N	N	N	1. Mid LAD + 2. mid LAD -	1.+ 2. +	1. Mild 2. -	1.Moderate 2.Moderate	1. Proximal +	1. +	1.Mild	1. Severe
3	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
4	1.Mid RCA +	1. +	1.Mild	1.Mild	N	N	N	N	1.Proximal LAD +	1. +	1. Severe	1.Severe	1.Normal	1.Normal	1.Normal	1.Normal
5	1.prox. RCA +	1. +	1.Mild	1.Mild	1.Mid LMCA +	1. Mid LMCA +	1.-Minimal	1. Minimal	1.Proximal LAD +	1. +	1.Severe	1.Severe	1.prox LCx +	1. +	1. Severe	1. Severe
6	1.Proximal RCA + 2. Mid RCA -	1. + 2. +	1. Moderate 2. -	1. Severe 2. Minimal	N	N	N	N	1. Proximal LAD + 2. Mid LAD +	1. + 2. +	1. Moderate 2. Occluded	1. Mild 2. Occluded	1. Mid LCX + 2. Mid LCX +	1.+ 2. +	1. Moderate 2. Severe	1. Minimal 2. Severe

7	1. Mid RCA +	1.Mid RCA +	1. Moderate	1. Severe	N	N	N	N	1. Mid LAD +	1. Mid LAD +	1. Moderate	1. Severe	1.Proximal LCx -	1. Proximal LCX +	1. -	1. Minimal
8	1. Proximal +	1. Proximal +	1. Occluded	1.Occluded	N	N	N	N	1. Proximal + Mid +	1. Proximal + Mid +	1.Moderate 2.Mild	1.Mild 2.Minimal	N	N	N	N
9	N	N	N	N	N	N	N	N	1. Proximal +	1. Proximal +	1. Severe	1. Severe	N	N	N	N
10	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
11	N	N	N	N	N	N	N	N	1. Mid + Distal +	1. Mid + Distal +	1.Severe 2.Moderate	1.Severe 2.Moderate	N	N	N	N
12	N	N	N	N	N	N	N	N	1. Mid +	1. Mid +	1. Mild	1. Moderate	N	N	N	N
13	1. Mid +	1. Mid +	1. Moderate	1. Moderate	N	N	N	N	1. Distal LAD -	1. +	1. -	1. Severe	1. Proximal +	1.Proximal +	1. Mild	1. Severe
14	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

15	N	N	N	N	N	N	N	N	1. Proximal LAD-	1. +	1. -	1. Minimal	N	N	N	N
16	N	N	N	N	N	N	N	N	1. Mid LAD +	1. -	1.Mild	1. -	1. proximal Lcx +	N	N	N
17	N	N	N	N	N	N	N	N	1. Distal LAD +	+	Severe	Severe	N	N	N	N
18	1. Mid RCA +	+	1. Severe	1. Severe	N	N	N	N	1.Proximal LAD + 2.Distal LAD +	1.+ 2. +	1. Severe 2. Severe	1. Severe 2. Severe	1.Proximal LCX +	1. -	1. Mild	1. -
19	1.Proximal + 2.Mid +	1. - 2. +	1. Mild 2. Occluded	1. - 2. Occluded	N	N	N	N	N	N	N	N	N	N	N	N
20	1. Proximal +	1. +	1. Occluded	1. Occluded	N	N	N	N	1. Proximal + 2. Mid +	1. + 2. +	1. Severe 2. Occluded	1. Severe 2. Severe	1. Mid LCx +	1. +	1. Severe	1. Severe